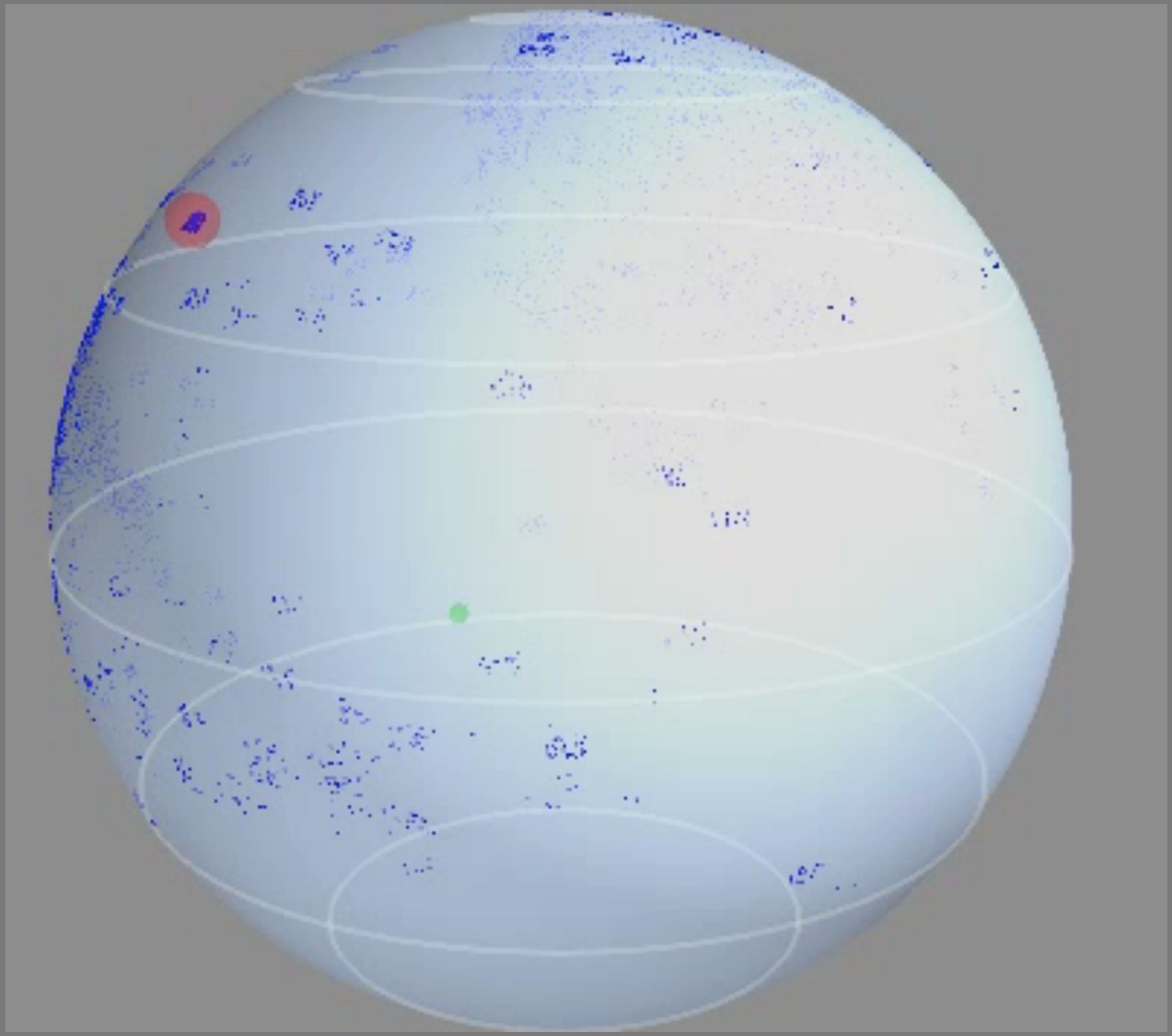


http://pairitel.org

THE SYNOPTIC ALL-SKY INFRARED SURVEY

SASIR

& Transient Followup

UC University of California

Instituto Nacional de Astrofísica, Óptica y Electrónica

UNAM Universidad Nacional Autónoma de México

THE UNIVERSITY OF ARIZONA

http://sasir.org

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SCIENTIFIC, EDUCATIONAL & TECHNOLOGICAL PARTNERSHIP ACROSS BORDERS

http://sasir.org

SASIR Partnership

UC University of California

Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE)

UNAM Universidad Nacional Autónoma de México

The University of Arizona

Key Personnel

UC: Bloom (PI), J. Xavier Prochaska, Mike Bolte (UCO/ Lick), Enrico Ramirez-Ruiz (UCSC), Peter Nugent, Chris Bebeck, Dovi Poznanski, Juan Meza, Rollin Thomas (LBL)...

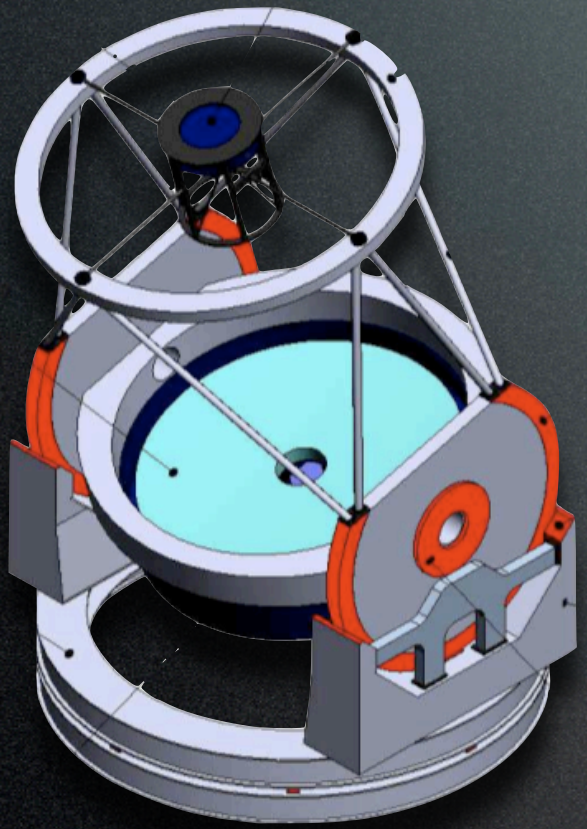
UNAM: Pepe Franco, William Lee, Jesus Gonzales

INAOE: Jose Guichard, Alberto Carramiñana

UofA: Peter Strimmatter, Peter Wehinger

SASIR Vision in a Nutshell

6.5 meter SPM telescope
(Magellan inspired)



- **site:** San Pedro Mártir (SPM), Baja California
- **Filters:** *Y, J, H, K* (3 dichroics)
- **Detectors:** 124 2k × 2k IR arrays
- ~1.05° diameter field of view
  - ➡ 2 sq. deg. on-sky
- autonomous/robotic surveying
- **Survey:** cover entire sky in ~2-3 months; 4 year survey
  - "shallow" (~2.5 π; 6-12 visits)
  - "medium" (0.5 π; ~200 visits)
  - "deep" (~1000 sq deg; 10^3+ visits) surveys
- on sky > 2017
- $150-200M (30% contingency)

New Phase Space:
Aperture + wavebands + Field of View + Time

SASIR Impact Across Astrophysics

- **Unveiling the Lowest Temperature Neighbors:**
  finding the local brown dwarf & Y dwarf population
  (candidates for exoplanet imaging)
- **Probing the Epoch of Reionization w/ Quasars**
- **Multi-messenger Probe**:
  Gravity Wave & Particle Counterparts
- **IR cosmology/distance ladder:**
  supernovae, RR Lyrae, Mira, etc.

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Synergies
- Large Millimeter Telescope (LMT)
- discovery engine for GTC, Keck, GSMTs, JDEM
- high-resolution dust maps (esp. in the Galactic Plane)
- adaptive optics grid
- photo-z improvement over optical-only (e.g. BAO)

Project Overview

[stuff we're sure about]

Mirror Casting

- Began in summer 09 (after ~11 years)
- High temperature phase (Aug 09)
- Figuring and Polishing (2010) → SPMT

outside the oven

inside the oven

Mirror Casting

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- High temperature phase (Aug 09)
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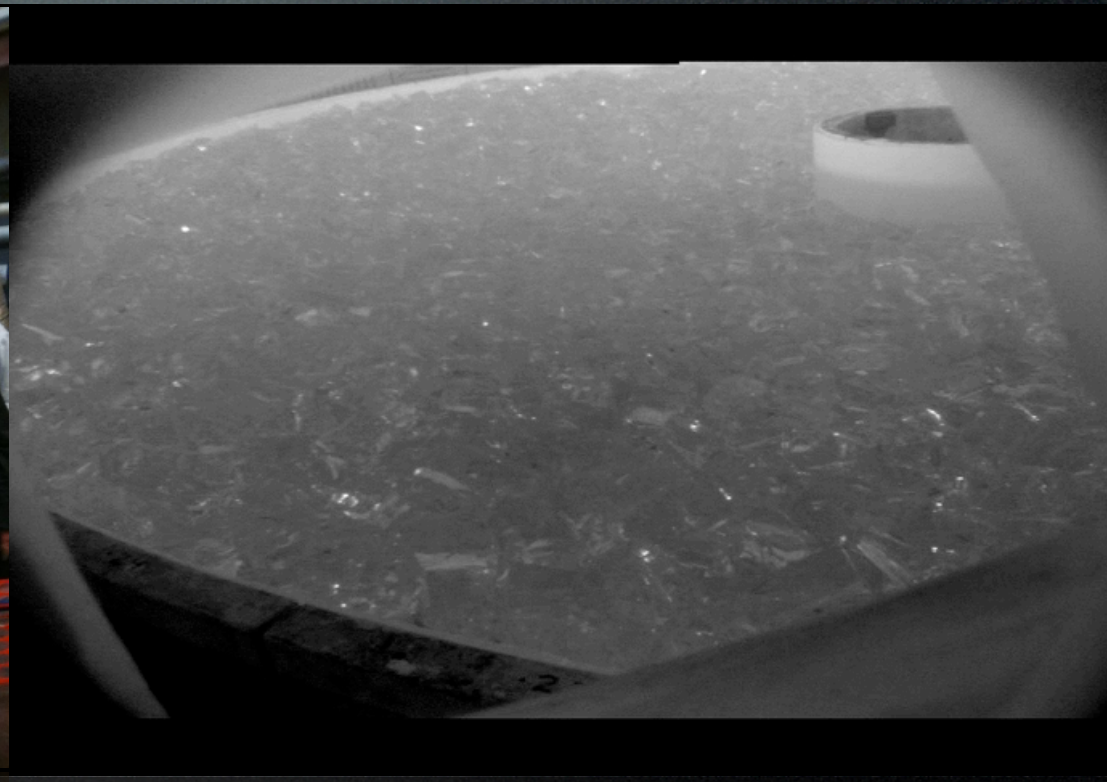
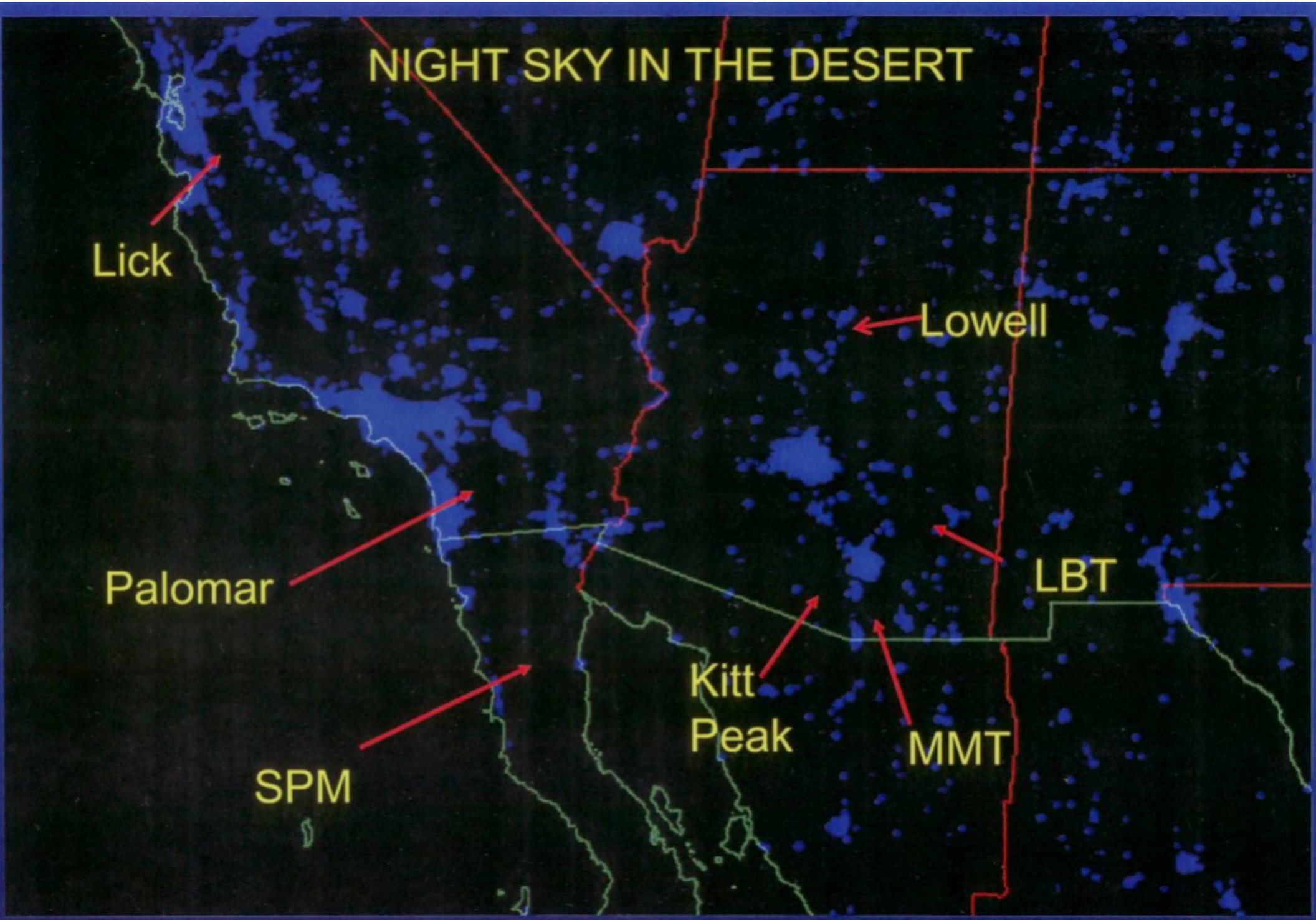
outside the oven



inside the oven



San Pedro Martir: Sky brightness > 21.6 mag/sq sec

Seeing…

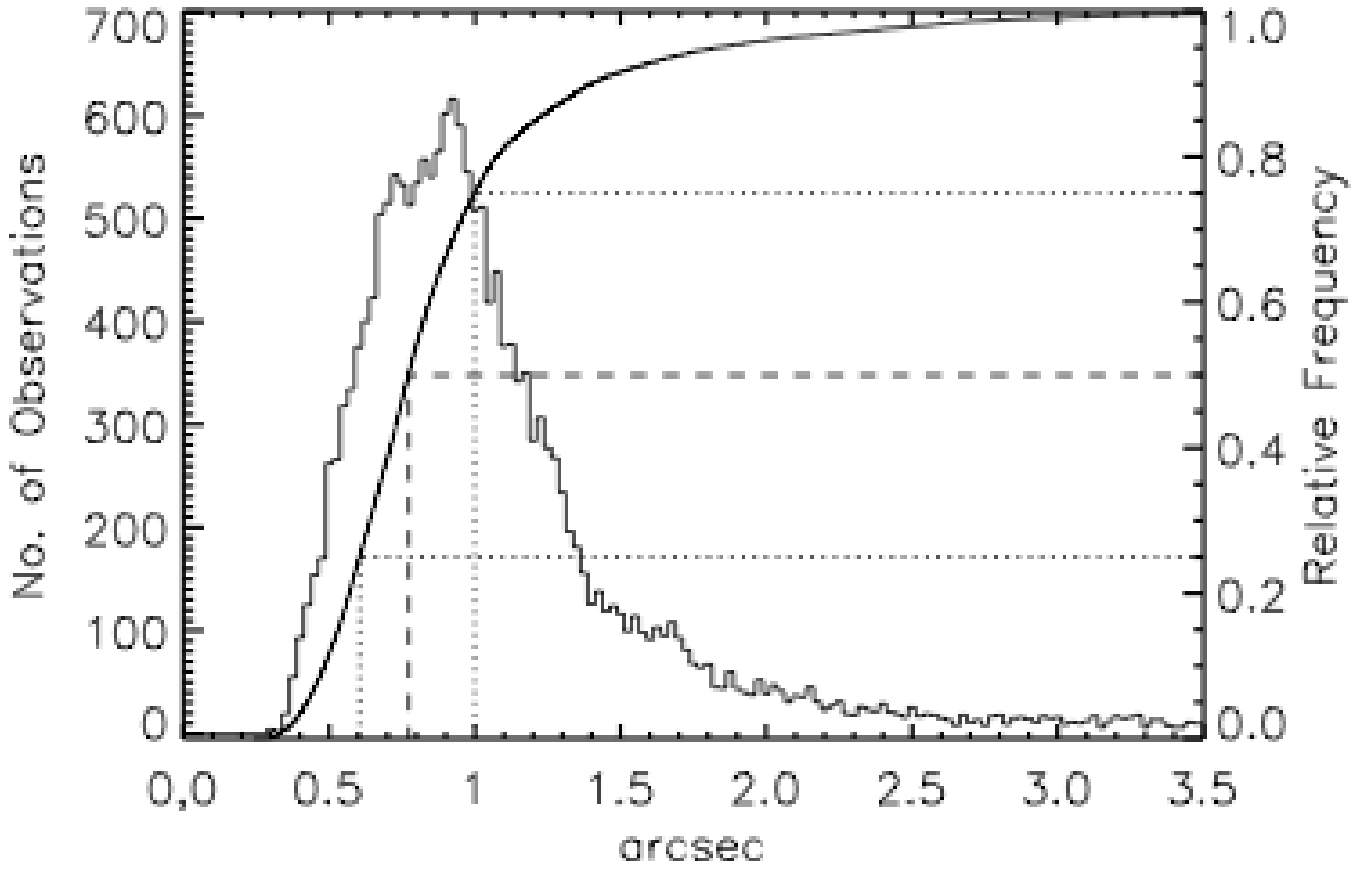


Fig. 10. Histogram and cumulative distribution function of the seeing values obtained with the DIMM during the four campaigns described in Sect 2.3.

V-band

Conan+02

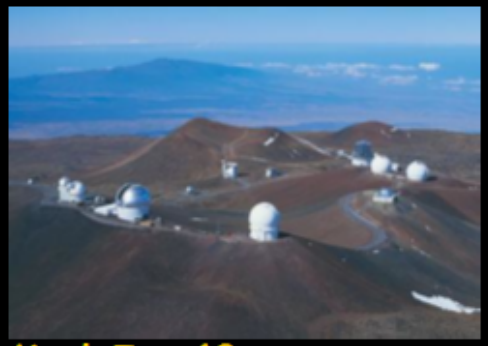
Sitios privilegiados para el visible y el Infrarrojo

Norte de Chile

Antu	8.2m	Europa
Kueyen	8.2	Europa
Melipal	8.2	Europa
Yepun	8.2	Europa
Gemini	8.1	USA UK Canadá Brasil Chile Australia Argentina
Baade	6.5	USA
Clay	6.5	USA
Soar	4.1	Brasil USA
Blanco	4.0	USA 74
"360"	3.6	Europa 77
NTech	3.5	Europa
duPont	2.5	USA 75
MPG-E	2.2	Europa

Construcción: 1,200 M$
Operación: 71 M$/año

Islas de Hawai



Keck I	10m	USA
Keck II	10	USA
Subaru	8.3	Japón
Gillet	8.1	USA UK Canadá Brasil Chile Australia Argentina
UKIRT	3.8	UK 79 Canadá, Holanda
AEO	3.7	USA-AF
CFHT	3.6	Canadá Francia USA 79
IRTF	3.0	USA
UH	2.2	USA 70

Construcción: 1,000 M$
Operación: 76 M$/año

Islas Canarias

GTC	10.4m	España México USA
Herschel	4.2	UK España Holanda
Galileo	3.6	Italia España
Newton	2.5	UK España Holanda
Nordic	2.5	Dinamrca Islandia Noruega Finlandia Suecia
Liverpool	2.0	Universitario

Construcción: 300 M$
Operación: 15 M$/año

San Pedro Mártir

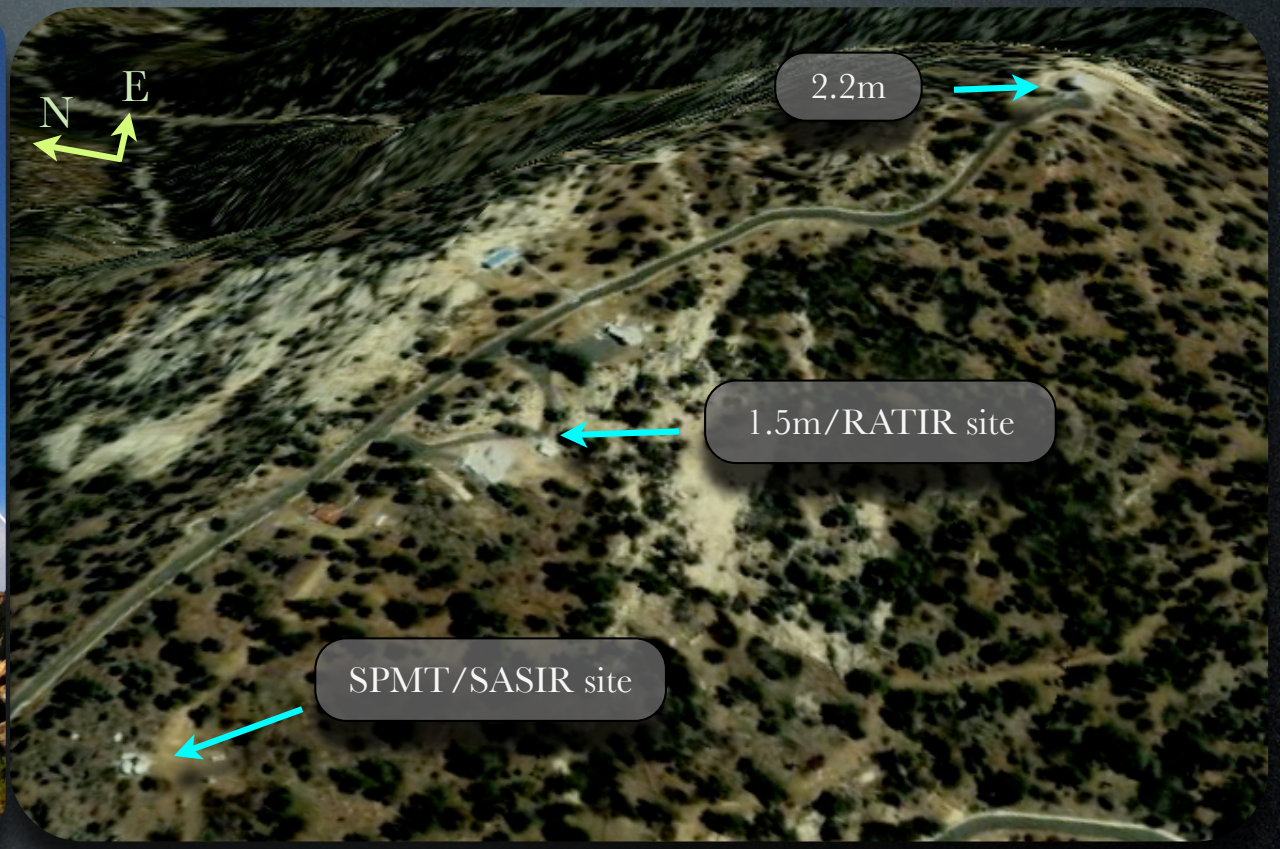
SPM	2.1m	México 79
SPM	1.5	México
SPM	0.8	México

Construcción: 5 M$
Operación: 1.0 M$/año

Inversión de Construcción: sólo considera los telescopios (y edificio) listados sin sus instrumentos.
Presupuesto de Operación (reportes anuales oficiales 2006): telescopios para Visible e Infrarrojo únicamente.
Se excluyen radio, solar, altas energías, etc. así cómo presupuestos y desarrollos fuera del observatorio en centros de administración, investigación o del consorcio o de socios

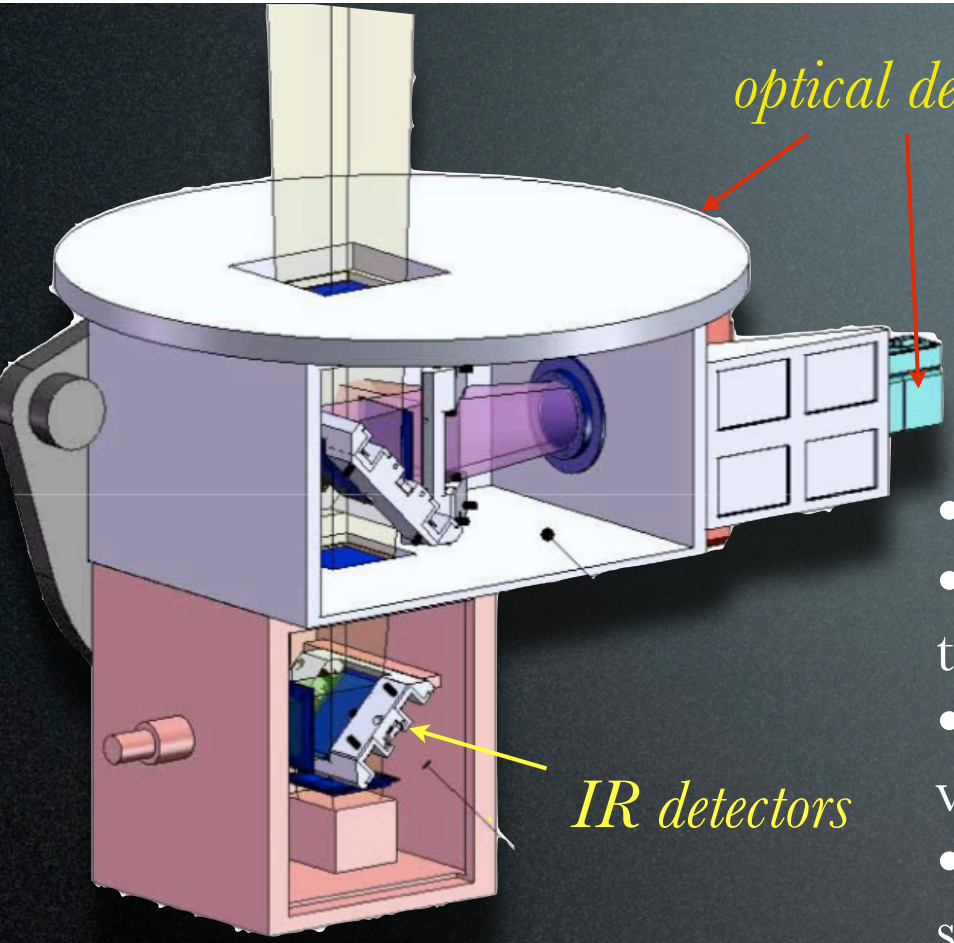
J. Gonzales

Site Selection & Observatory Development



SASIR site = LSST Testing site

[6.5m aluminizing mirror & facilities upgrade requested from UNAM]



Reionization & Transients Infrared (RATIR) Project

2010-2012

- UC/Mexico collaboration building
- Grow on-mountain expertise in robotic telescopes
- Gain in-collaboration experience with vendors, IR design
- Build expertise with modern IR imaging systems (here, H2RGs)

Science driver:
OIR time-domain
rapid follow-up/monitoring
(e.g., GRB photo-z's)

- ***Rapid deployment on 1.5m at SPM***
  - ➡ Mar 09: CDR
  - ➡ Fall/Winter/Spring 09/10: construction
  - ➡ Summer 10: first light

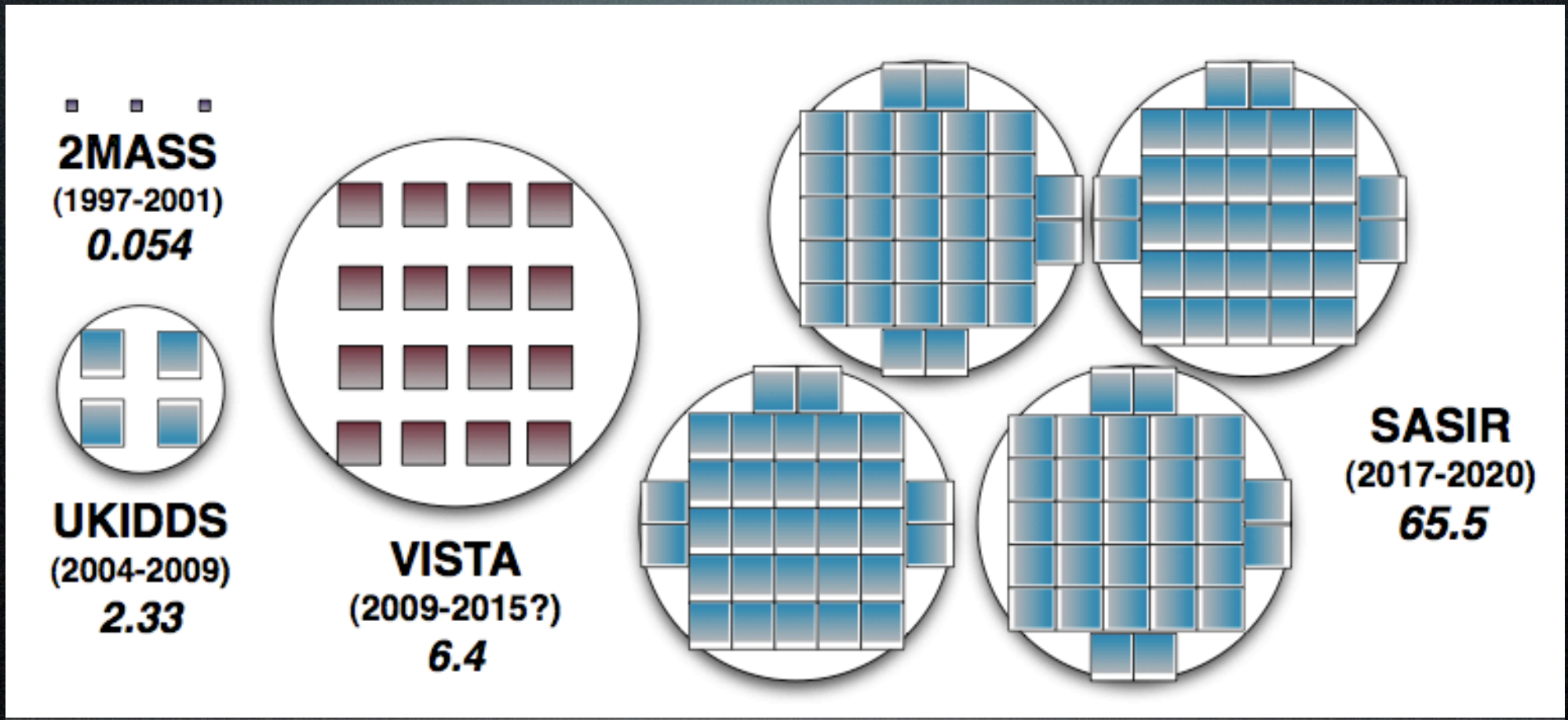
http://ratir.org
Nat Butler (UCB), PI

Funded by Goddard and Mexico with minor support from UCO, has a very short fuse.

Project Overview

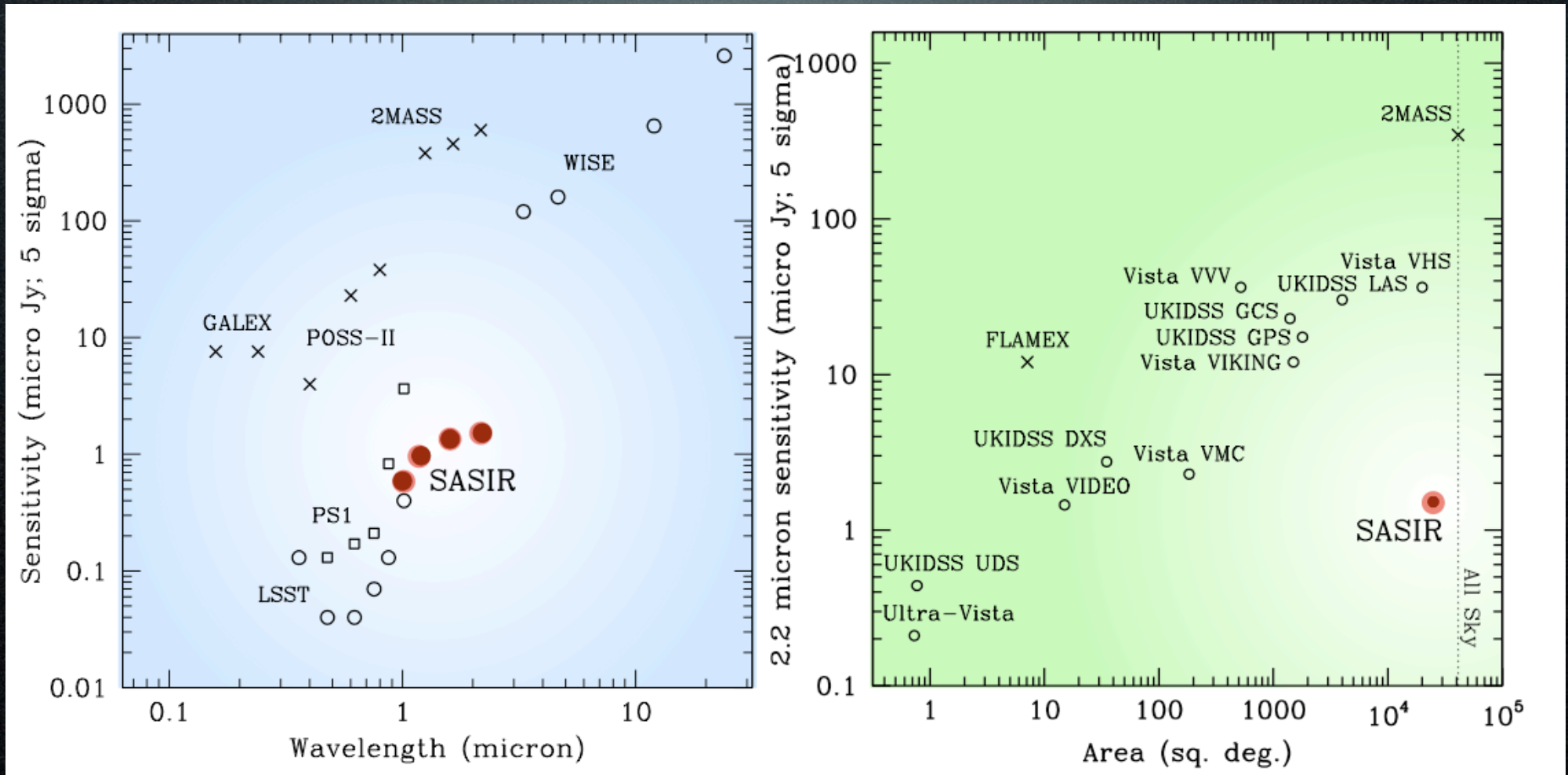
Pre-Conceptual Design
[stuff we've been thinking about]

Comparison to Other Surveys



étendue-couleur© (m^2 deg^2 × number of simultaneous bands)

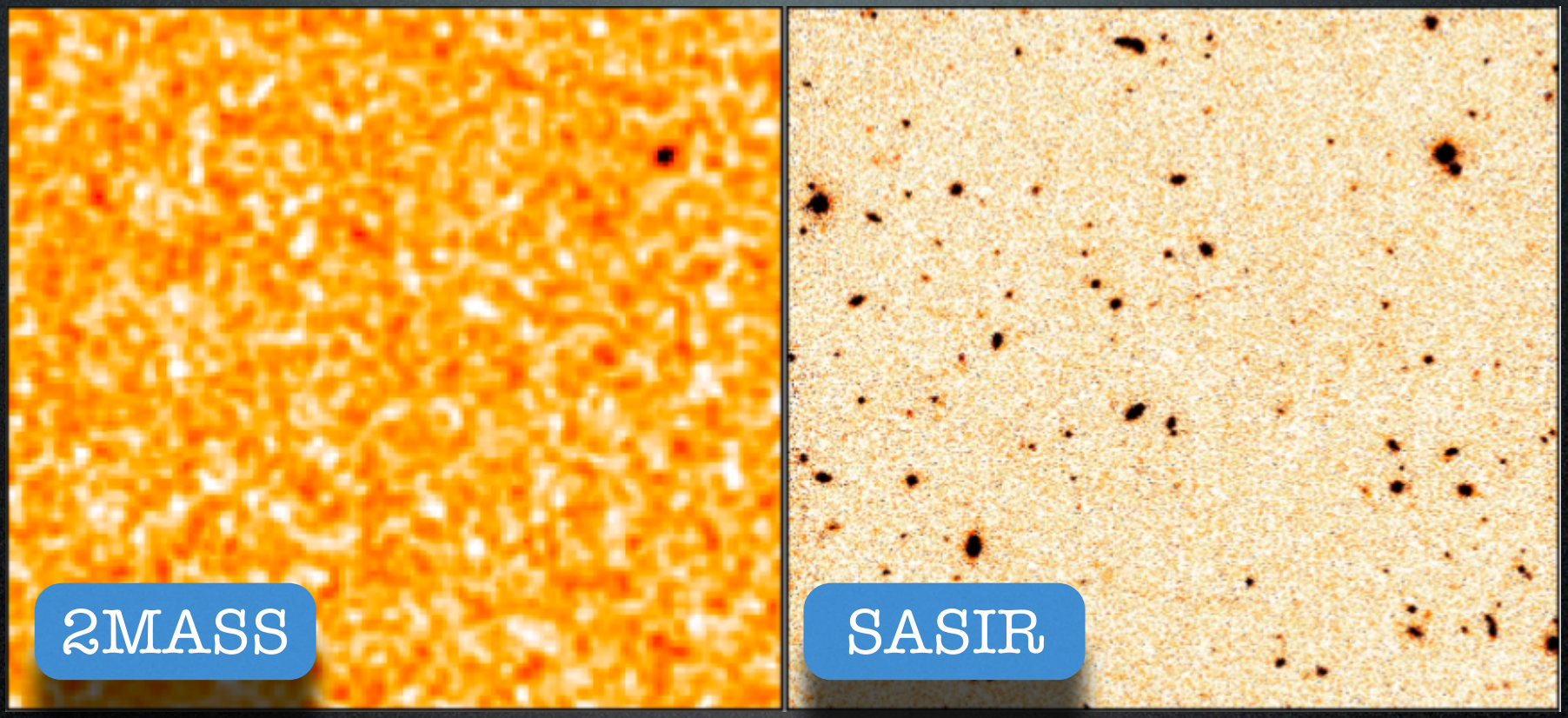
Comparison to Other Surveys



other survey data compiled by D. Stern (JPL)

Comparison to Other Surveys

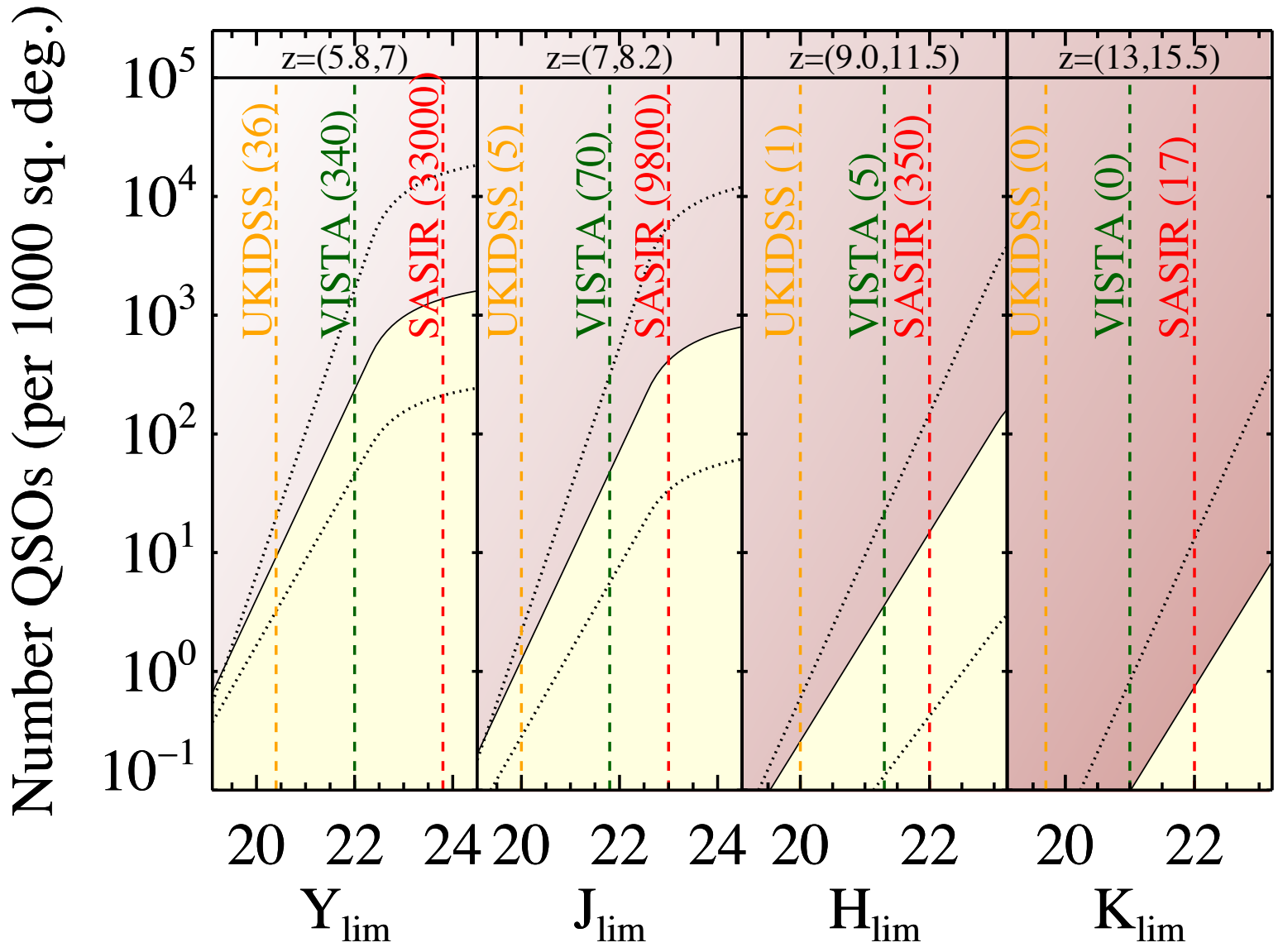
K-band Imaging



2MASS [Skrutskie *et al.* 2006]

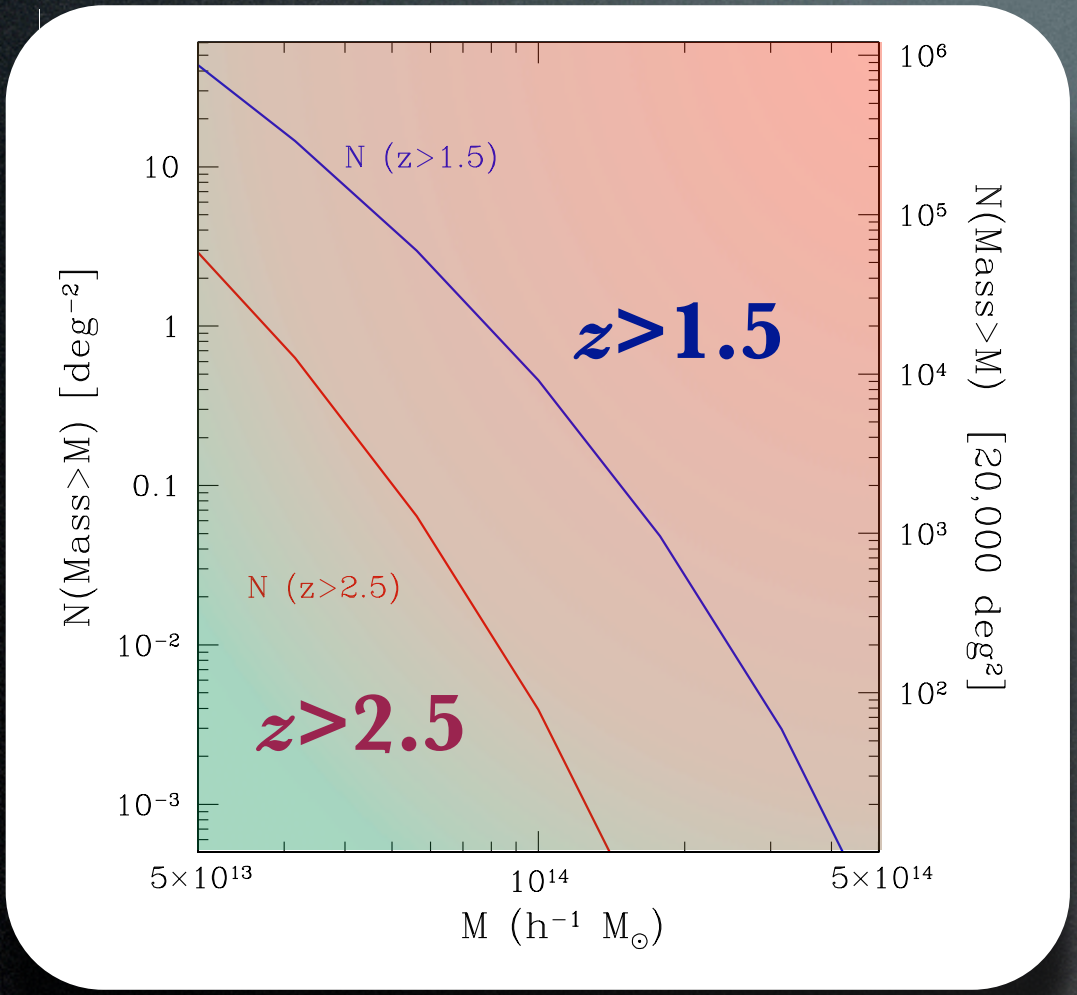
VLT/ISSAC (GOODS) [Retzlaff *et al.* 2008]

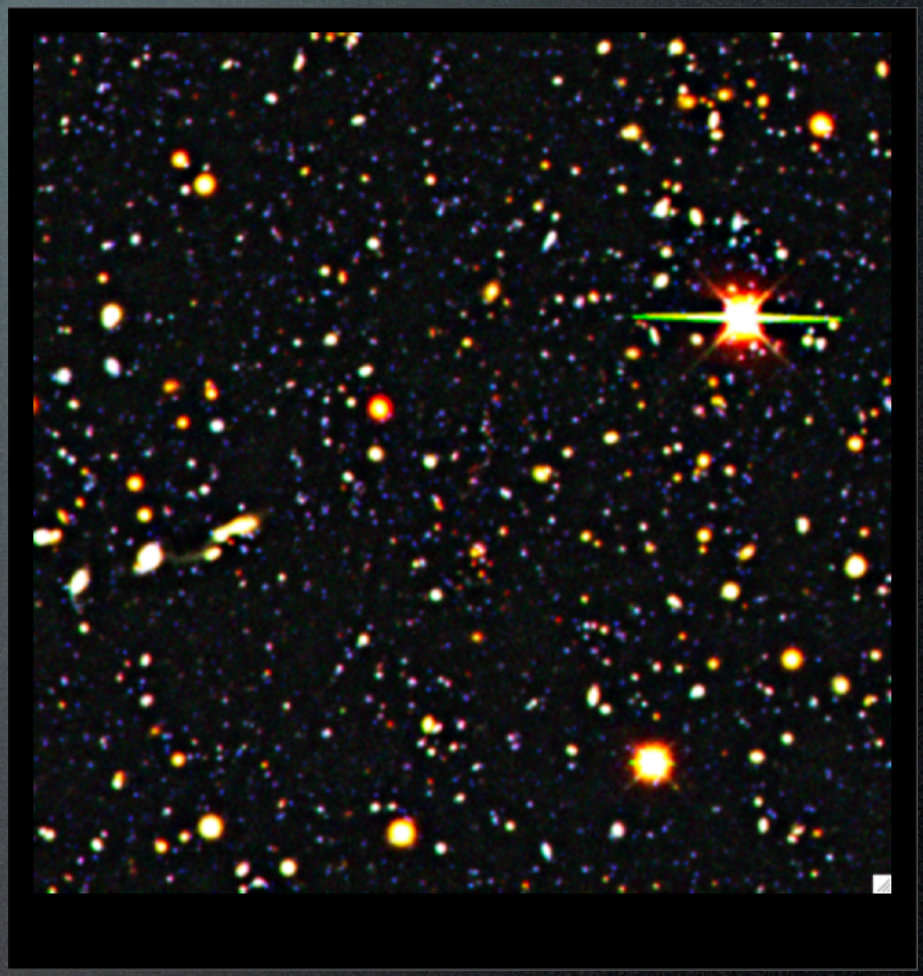
Discovering the High-redshift Universe



J. X. Prochaska+09

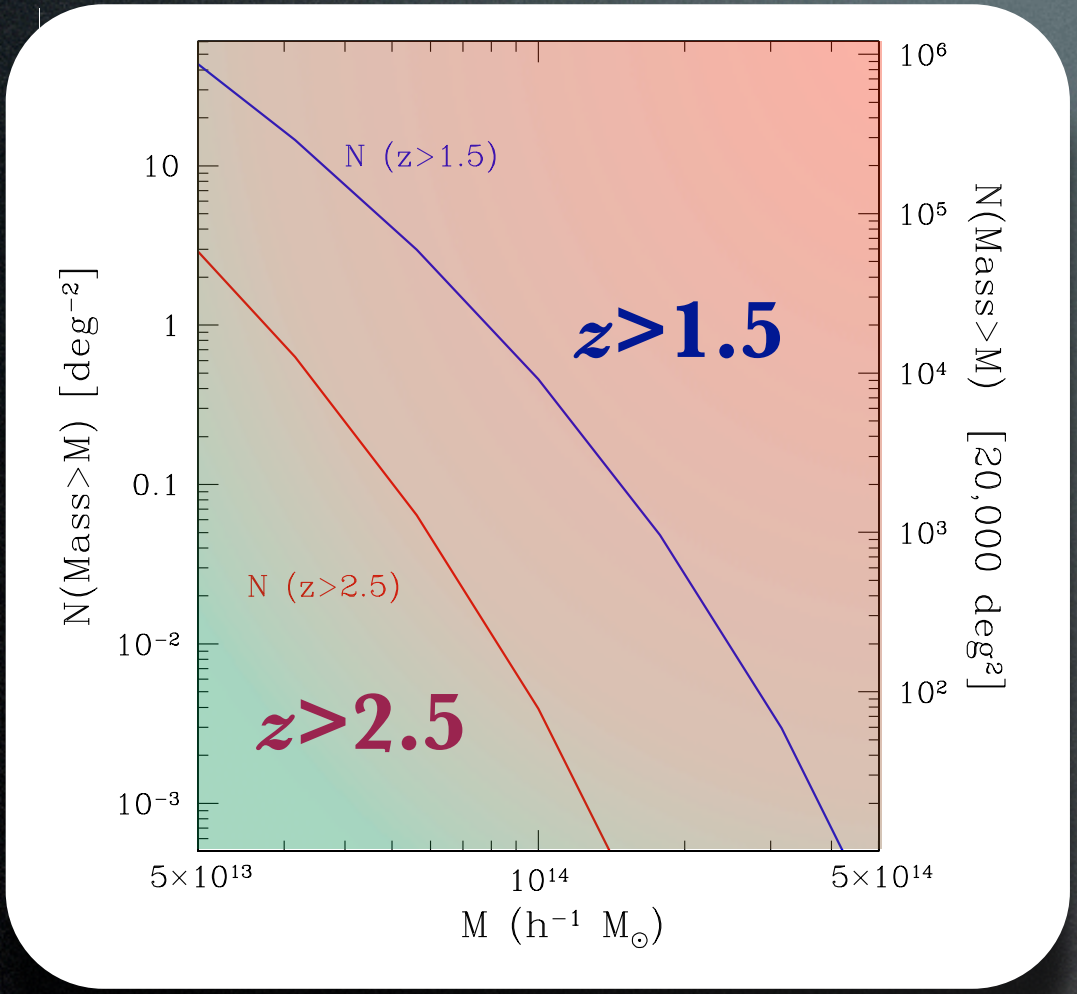
Finding Massive Clusters beyond $z \sim 1.5$

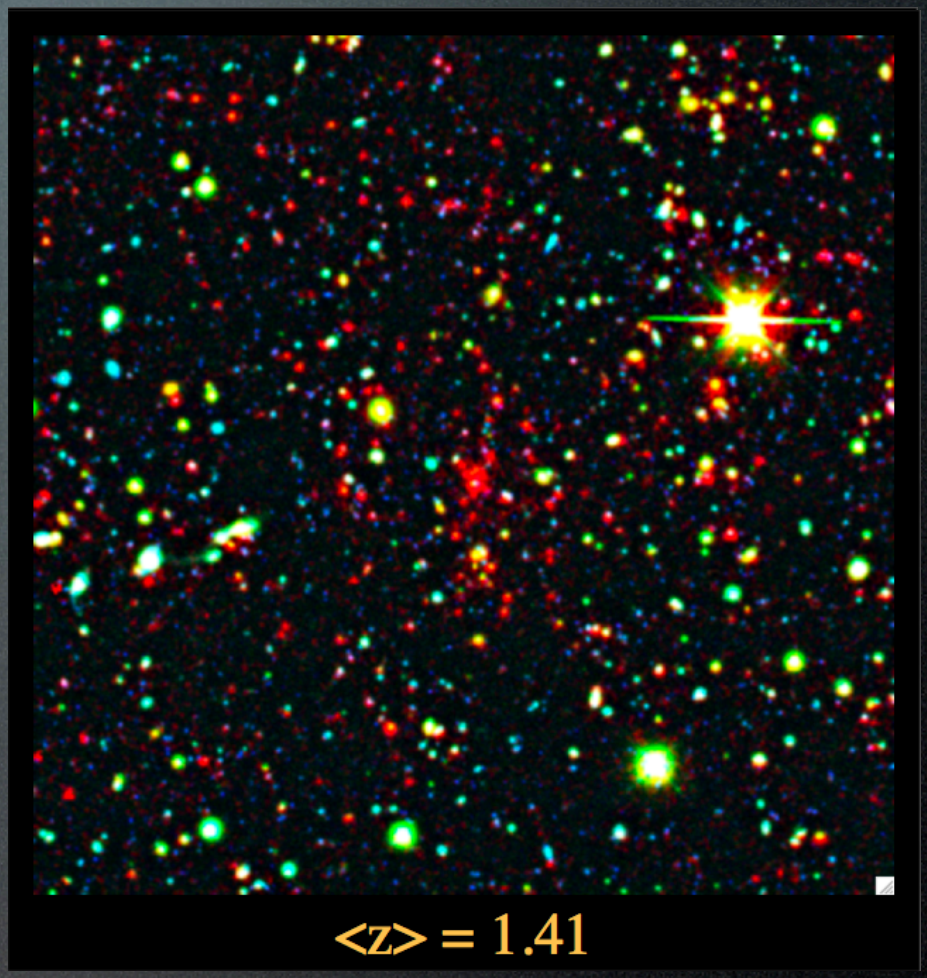




Stanford et al. 2005 (ApJ, 634, 129L)

Finding Massive Clusters beyond $z \sim 1.5$

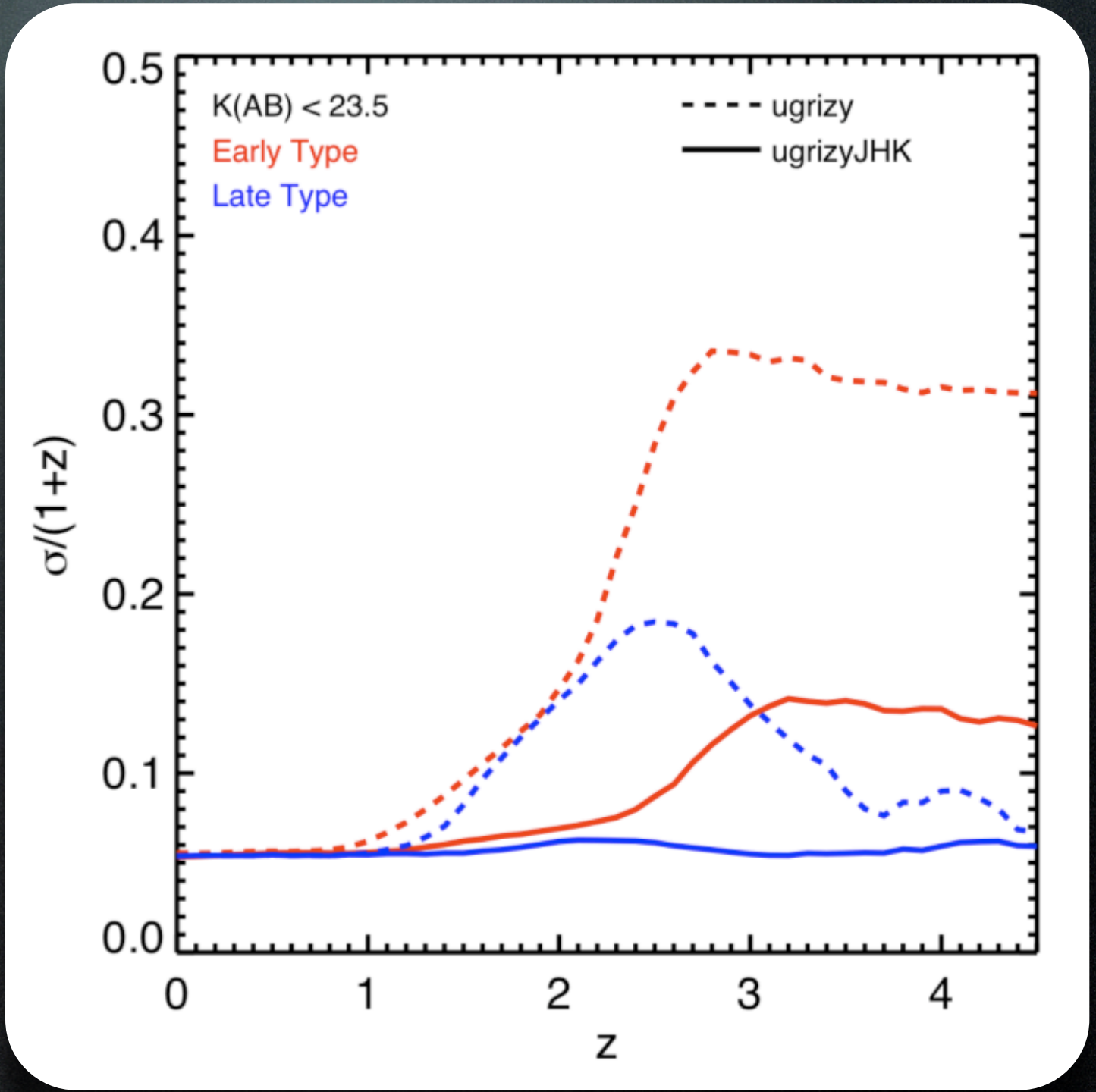




w/IR

Stanford et al. 2005 (ApJ, 634, 129L)

Improved photometric redshift errors



Brodwin+06

Galactic IR Time-Domain

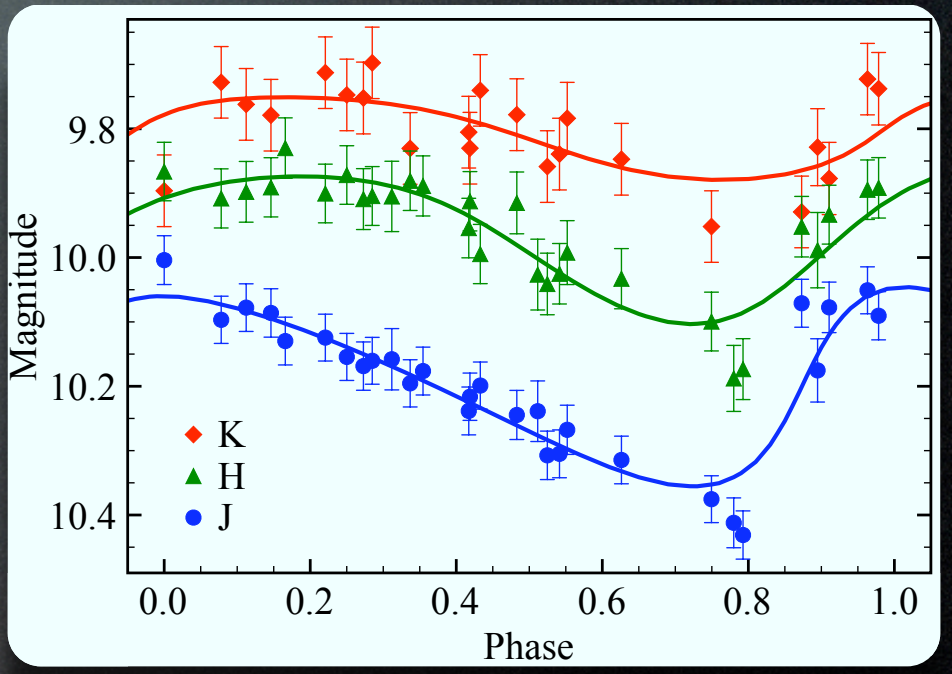
Local Distance Ladder Calibration

- pulsation-luminosity relation (theoretically) less sensitive to metallicity so maybe more standard
- dust mitigation

Galactic Structure at low *b*

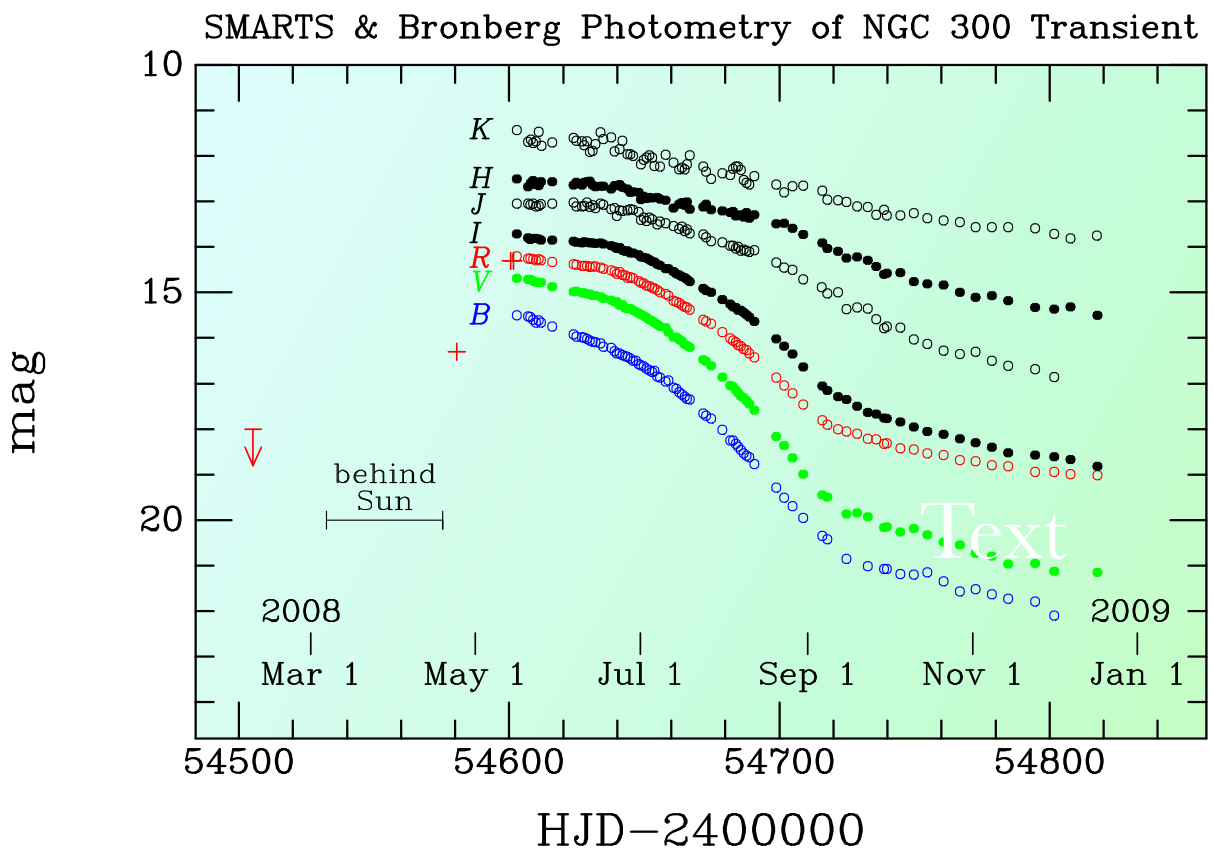
- RRLyrae, Cepheid, Miras through the Galactic Plane

Low-Mass Eclipsing Binaries



PAIRITEL Pilot Program (C. Klein)

Extragalactic IR Time-Domain



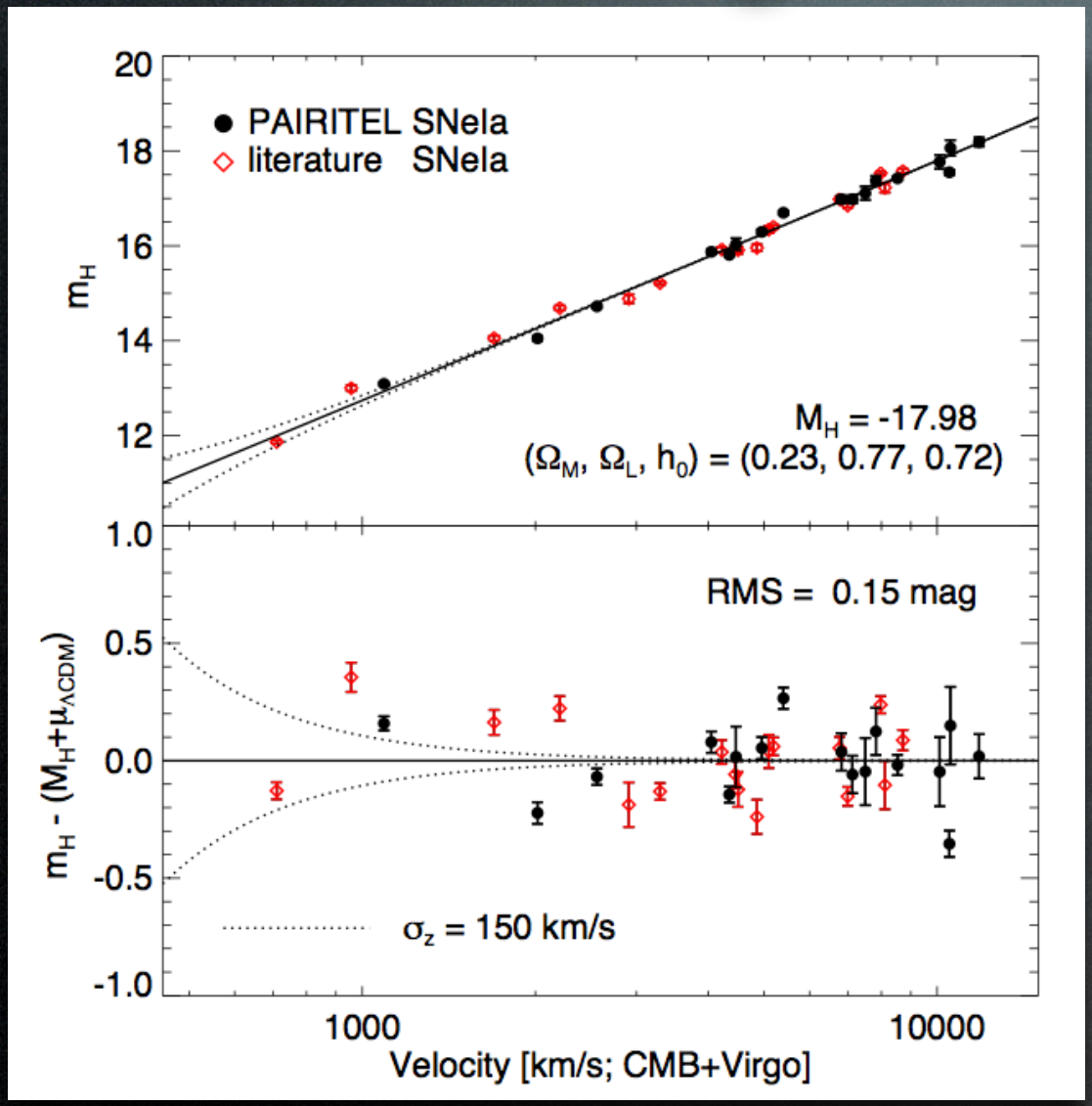
- new class of red novae
- M_K(peak) = -12 mag
  - SN 2008S
  - NGC300-T
  - M85-T
  - UGC 2773-T
- timescales between SNe & novae

Bond+08

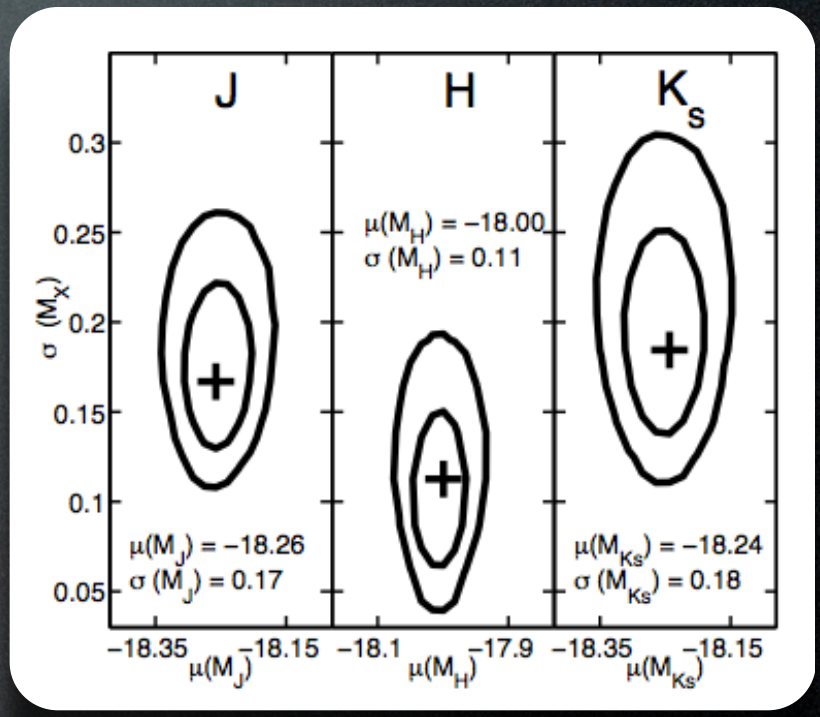
Possible origins:

LBV-like, electron capture SNe, dust enshrouded SNe, luminous mass transfer event, eruption during WD formation

Extragalactic IR Time-Domain



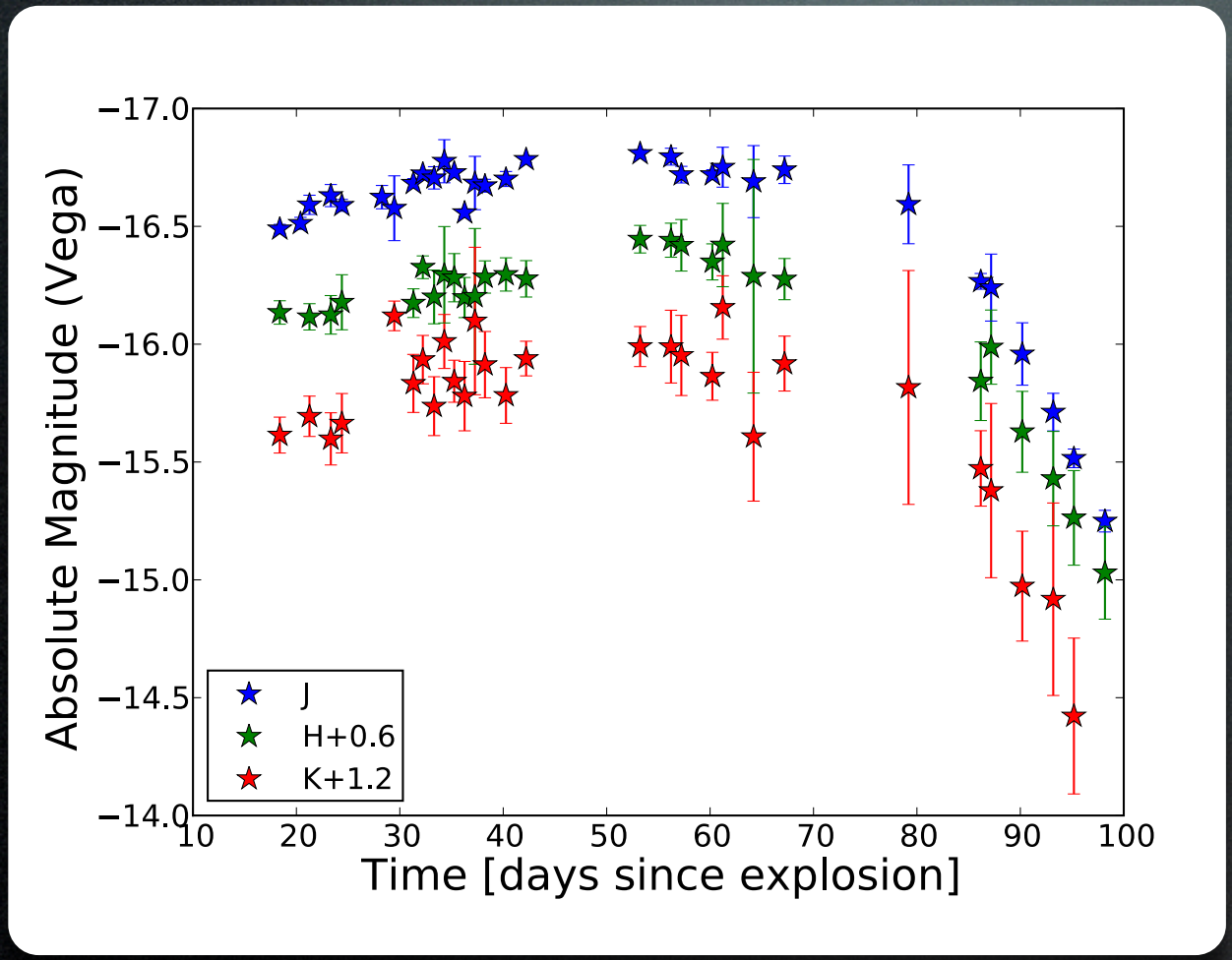
Type Ia SNe looking rather standard in the IR



Wood-Vasey, Friedman, Bloom et al. 2008

Mandel+09

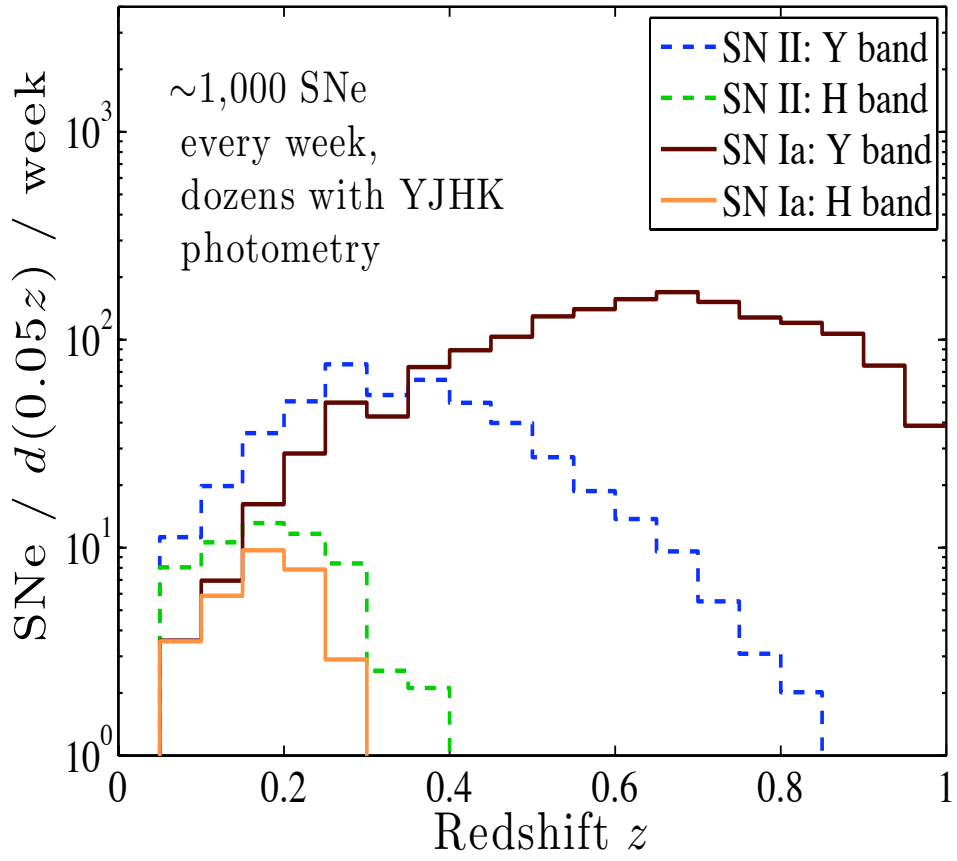
Extragalactic IR Time-Domain

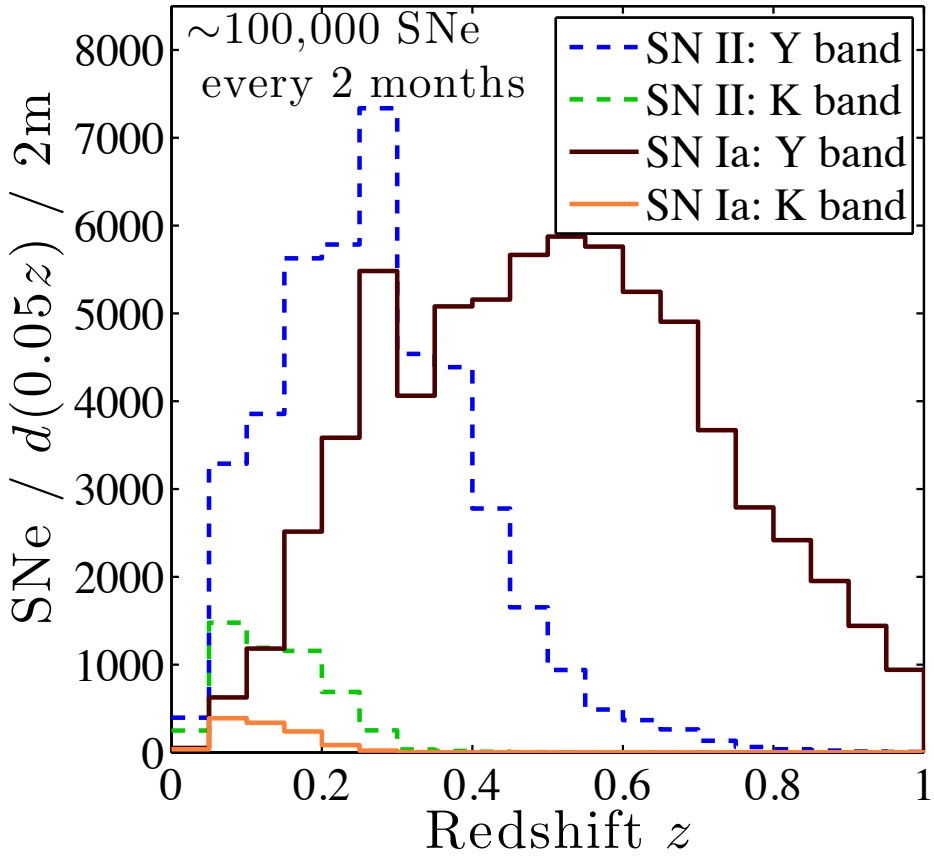


Type IIP in the optical also look good, but unknown in the IR...

<u>Pilot Program</u>
w/ D. Poznanski, Adam Miller, Michelle Kislak

Extragalactic IR Time-Domain



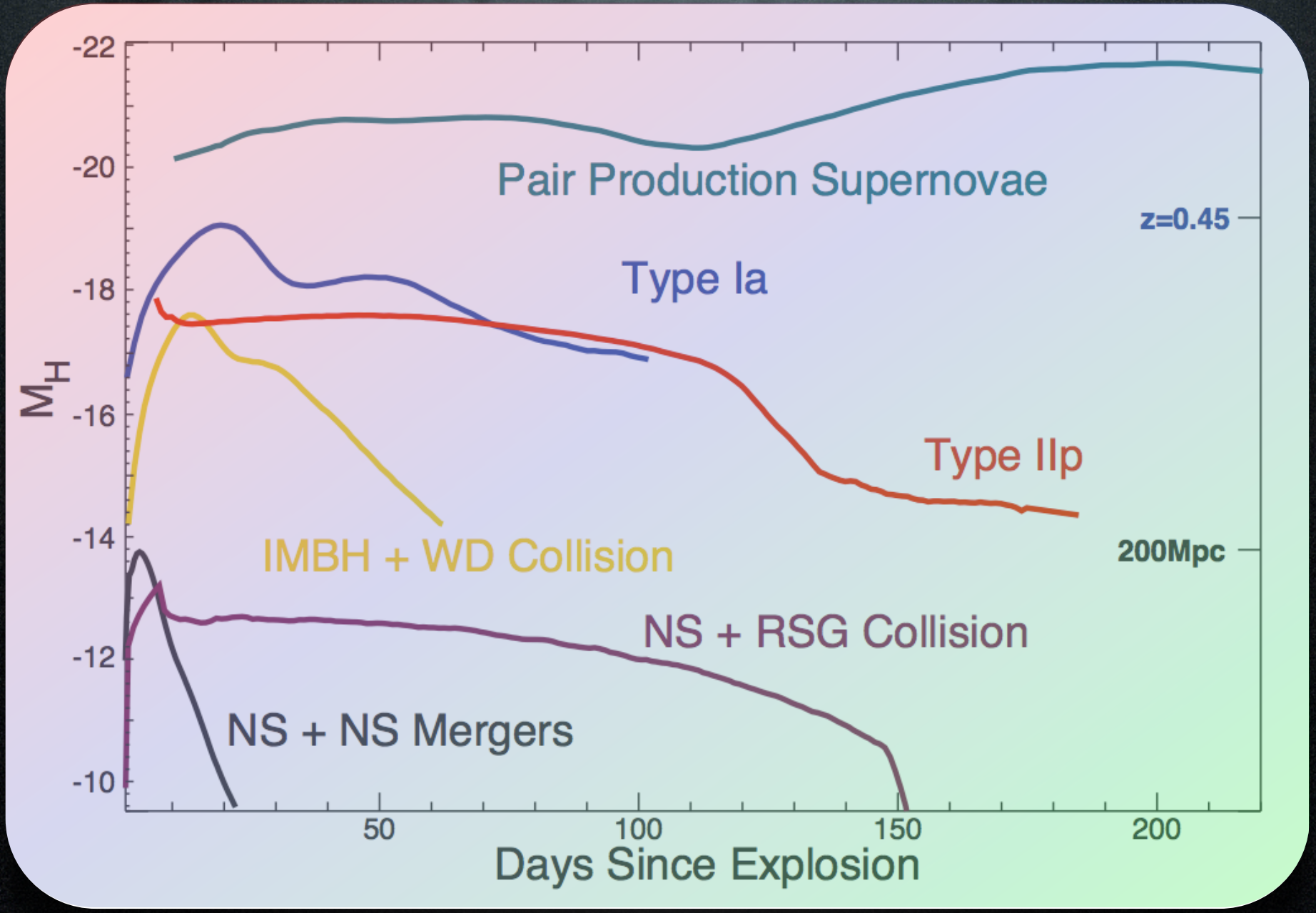


we expect a huge net of SNe

1 yr, 45 epochs 1000 deg^2

D. Poznanski

IR Transient Universe: Explosive Systems



Enrico Ramirez-Ruiz

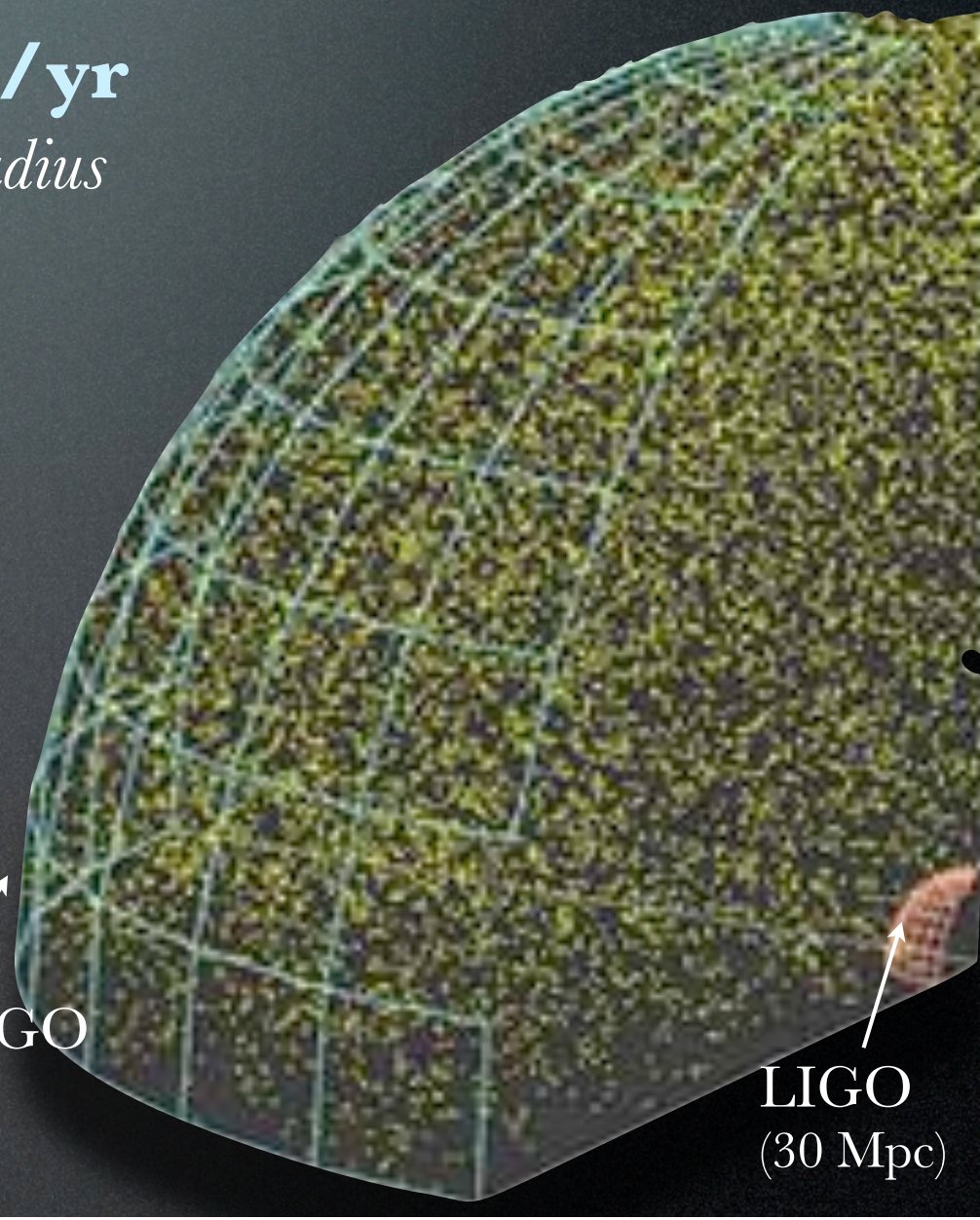
Gravitational Wave & Neutrino Follow-up

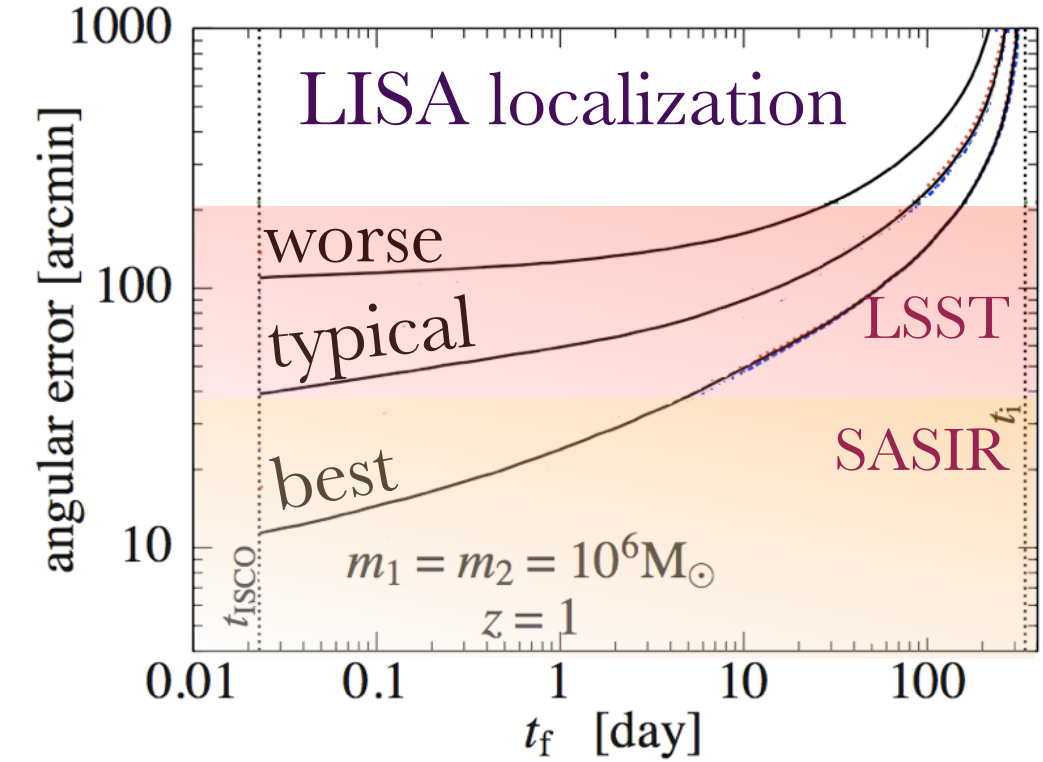
E&M connection to the next generation observatories

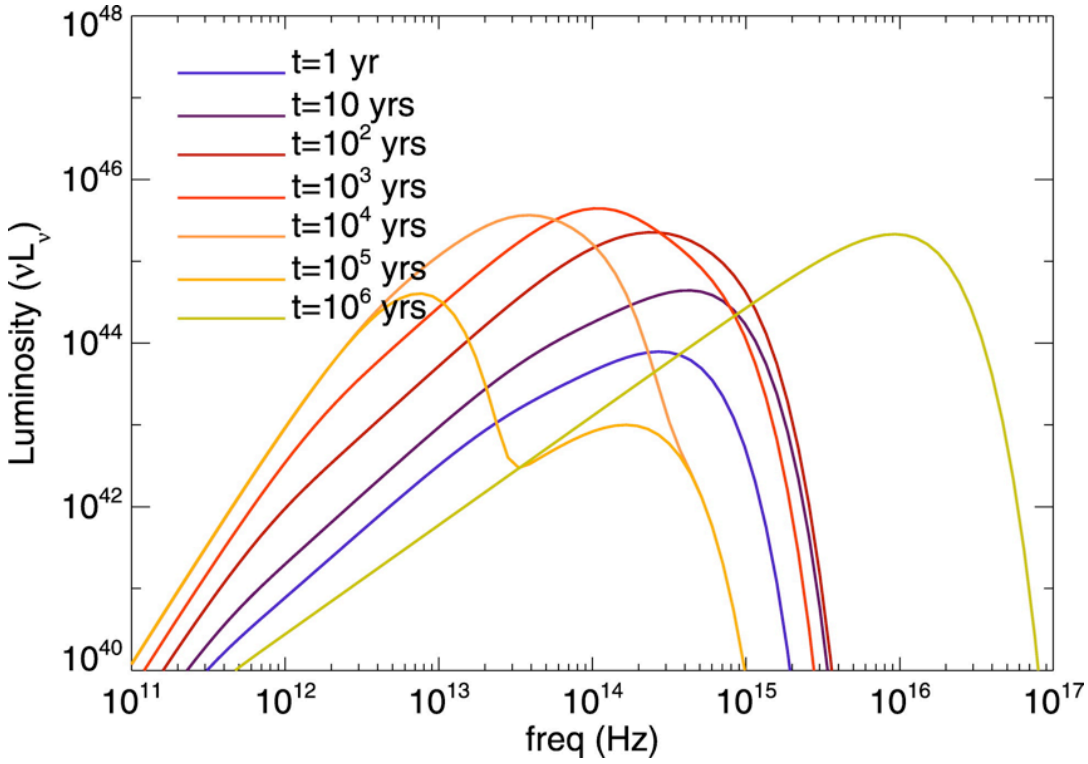
Advanced LIGO Rate: 40/yr

but localization accuracy ~10 deg^2 radius

SASIR: unique FOV + aperture, well-suited to rapid follow-up



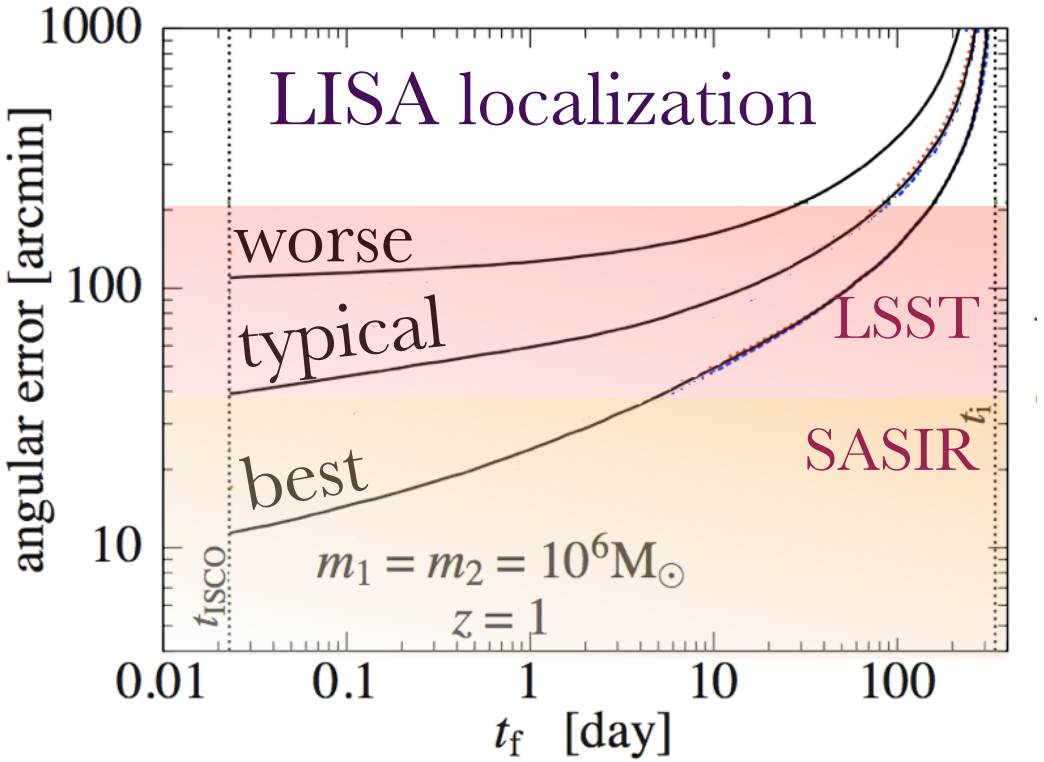


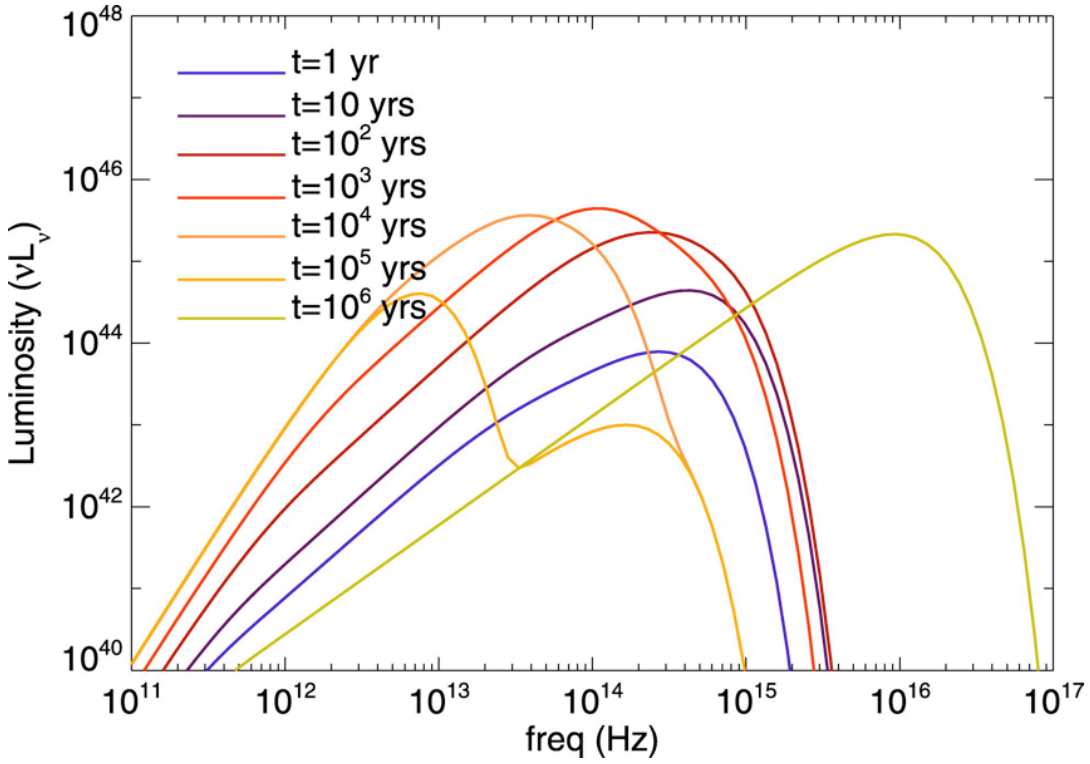


MBH-MBH mergers: Periodic transients prior to coalescence, infrared afterglows afterwards

EM event discovery (via time variability) breaks the ~deg^2 GW localization problem

Schnittman & Krolik 08
Haiman+08





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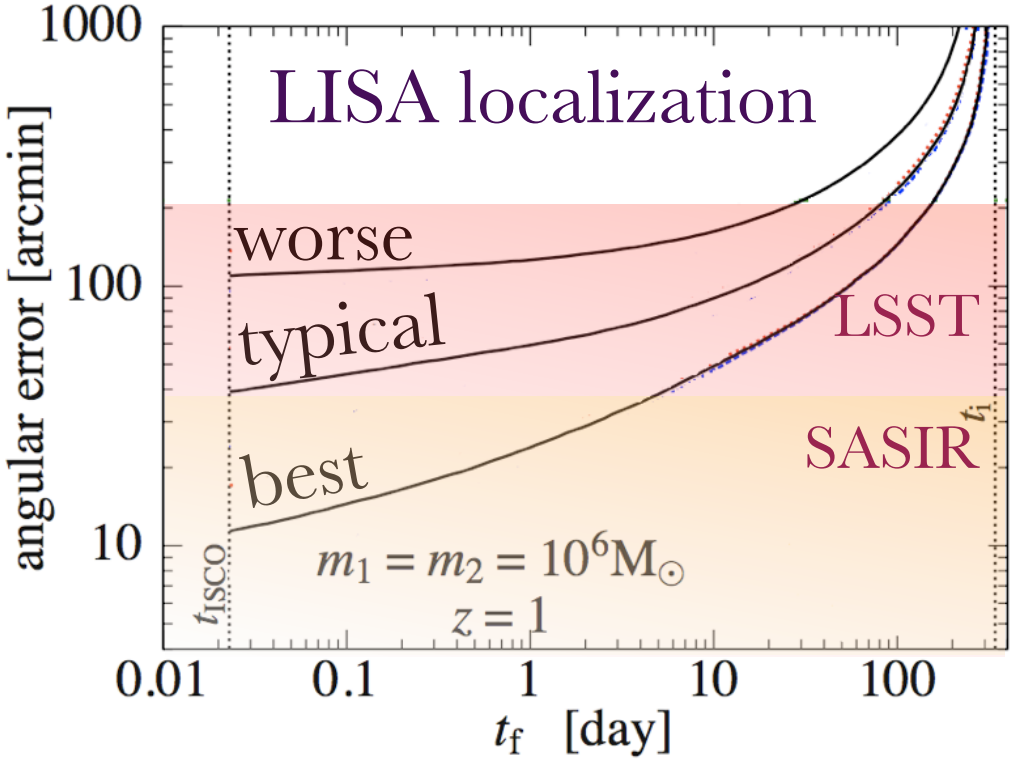

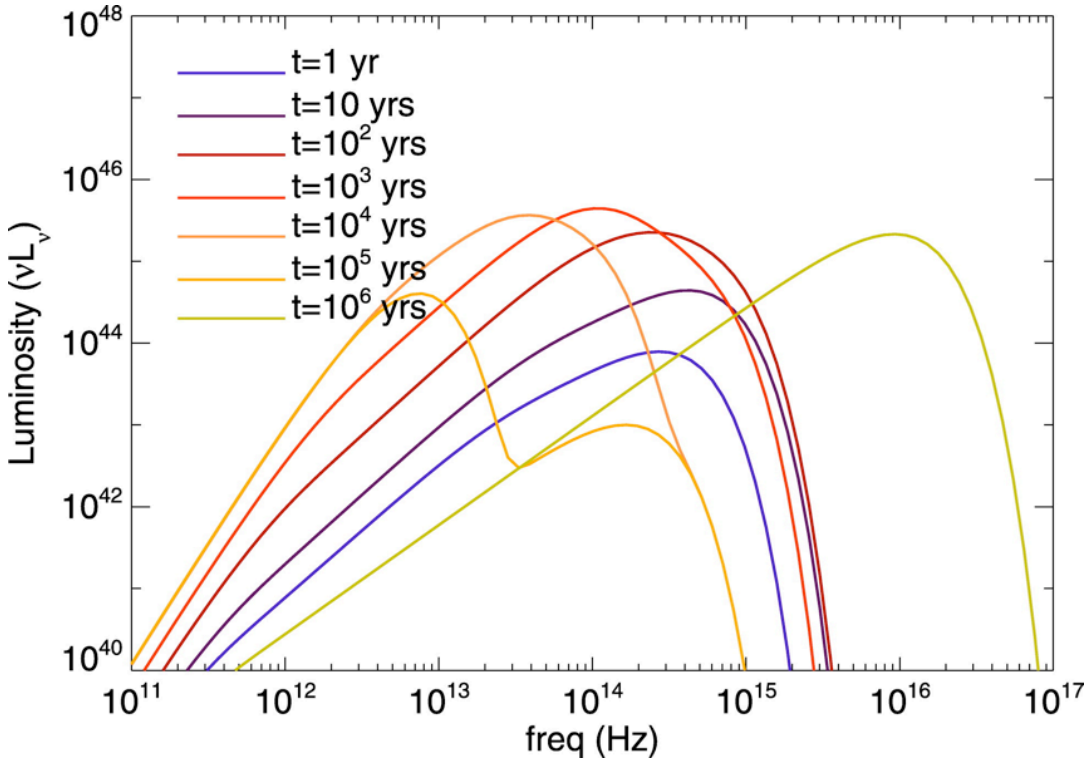

MBH-MBH mergers: Periodic transients prior to coalescence, infrared afterglows afterwards

EM event discovery (via time variability) breaks the ~deg^2 GW localization problem

BigBoss spectra of LISA/aLIGO possible hosts?

GW chirp gives d_L to 1% (@ z=1) + host redshift:
new precision cosmology tool

Schnittman & Krolik 08
Haiman+08

(Pre-Conceptual Design) Schedule

1. **Project Establishment (2009)**: a) Establish the Project Office and structure, including Project Manager, Project Scientist, Science Advisory Committee and Legal and Environmental Issues Panel b) Define the scientific requirements. Terminates in Project Definition Review.
2. **Conceptual Design (2010–2011)**: a) Perform trade studies on cost, schedule, organization, performance and use; characterize the elements that will ensure delivery of the project requirements; Develop a Survey Operations Simulator; Select the final concept for the system identifying possible rescopes. b) Produce a Conceptual Design Document, a System Requirements Document, a Management Plan, a System Engineering Plan, c) develop the Data Management architecture. Terminates in System Conceptual Design Review.
3. **Detailed Design (2012–2013)**: a) Perform detailed designs to meet System Requirements, b) Produce a Design Document, an Instrument Allocated Baseline with technical specifications, a complete 3D model and assembly diagrams, an Error Budget Document for mechanical parameters, and a Design Review Document. Terminates in Critical Design Review.
4. **Project Construction (2014–2016)**: Construction of the SASIR camera, telescope, building, optics, control system. Terminates in Operation Review
5. **SASIR Survey (2017–2021) and wrap-up activities (2022)**. SASIR Survey operations, including science meetings, postdoctoral positions, data archiving, data releases and outreach and extension activities. Terminating in SASIR End Review

(Pre-Conceptual Design) Schedule

	Total	Cash Flow (year 1 to 15) Millions of USD (FY2009)														
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PRECONCEPT AND FEASIBILITY STUDY	0.25		0.25													
PROJECT DESIGN & ESTABLISHMENT	0.30	0.03	0.12													
SCIENCE DEFINITION	0.20		0.15	0.05												
PROJECT MANAGER	1.80	0.12	0.24	0.24	0.24	0.24	0.24	0.24	0.24							
SYSTEM ENGINEER	0.85	0.05	0.10	0.15	0.10	0.15	0.10	0.10	0.10							
CIVIL ENGINEERING (Dome & Building)	19.45		0.90	2.65	4.40	5.55	4.23	1.48	0.24							
TEL. MECHANICS (Design, Construction, Integration)	10.39	0.05	0.68	0.28	2.19	2.95	1.93	0.88	1.45							
TEL. & WFC OPTICS (Design, Manufacture, Integration)	21.55		1.70	0.35	2.90	4.65	5.84	4.83	1.28							
COATING & AUXILIARY SERVICES	5.00				0.75	2.00	1.50	0.50	0.25							
TELESCOPE CONTROL SYSTEM	2.35		0.08	0.18	0.33	0.43	0.65	0.48	0.23							
SASIR CAMERA (Design, Manufacture, Integration)	50.23		0.15	0.73	5.53	7.85	10.00	9.65	16.33							
SASIR SURVEY	28.15								1.28	4.77	4.72	4.77	4.72	4.77	1.63	1.53
TOTAL 15-yr PROJECT	**140.52**	**0.25**	**4.39**	**4.75**	**16.43**	**23.82**	**24.49**	**18.15**	**21.39**	**4.77**	**4.72**	**4.77**	**4.72**	**4.77**	**1.63**	**1.53**
Contingency (25%)	35.13	0.06	1.10	1.19	4.11	5.95	6.12	4.54	5.35	1.19	1.18	1.19	1.18	1.19	0.41	0.38
TOTAL with 25% Contingency	**175.65**	**0.32**	**5.49**	**5.93**	**20.53**	**29.77**	**30.61**	**22.69**	**26.73**	**5.96**	**5.89**	**5.96**	**5.89**	**5.96**	**2.03**	**1.91**
Project Phase		**PROJECT DEFINITION**				**PROJECT CONSTRUCTION**				**SCIENCE OPERATIONS**						
Financial Sources:		**NSF, CONACyT & UC, UNAM, INAOE**				**Private, Federal & Partner Institutions**				**Federal, Private & Partnership Institutions**						

Beginning of Science Operations: 2017

a raft of proposals to NSF, CONACyT, UCMEXUS

Funding

As Proposed:

Design phases:

50/50 US/Mexico Federal Funding (90%)
Institutional & Private (10%)

Construction phases:

Significant private funding (~70%), Institutional (5%),
Mexican Federal (25%), **US Federal (0%)**
US partners responsible for camera ($50M)
Mexico responsible for telescope & observatory

Survey phase:

50/50 US/Mexico Federal Funding (90%)
Institutional & Private (10%)

Summary

- The SASIR Survey would be a unique combination of aperture + wavelength + time cadence

- Well-matched for the Mexican 6.5m telescope & community science interests/expertise

- Very likely will need more partners both technical & scientific

http://sasir.org

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Research Note

Variable Star BB Cam*

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Summary. The photometric study of the variable star BB Cam results of a long series of photographic observations (m_{pg} and m_r) taken with the 80 cm and Schmidt telescopes of the Observatoire de Haute Provence. After the creation of two sequences of blue and red magnitudes in the field of the variable, the photometric measurements of 102 blue plates and 100 red plates allowed us to establish two light curves (m_{pg} and

Key words: variable stars — metry — galactic structure

Résumé. L'étude photométrique BB Cam résulte d'une longue photographiques (m_{pg} et m_r) fait 80 cm et de Schmidt de l'Observ vence. Après la création de deux